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DOCTOR FRANK M. SWARTZ, The Pennsylvania State College, State College, Pa.: *Silurian and Early Devonian Studies in the Middle Appalachians.*[1] (This lecture was illustrated by lantern slides.)

Historically, the modern knowledge of Appalachian Silurian deposits and faunas began with the work of James Hall in western New York. A further great advance was the elaboration of the sequence of these strata in western Maryland, accomplished by 1923 through the labors of C. K. Swartz, W. F. Prouty, E. O. Ulrich, G. W. Stose, and others.

During subsequent years, it has been the writer's privilege to be associated with C. K. Swartz in investigations, still largely unpublished, of the Silurian and, to some extent, the early Devonian from Maryland through the Virginias into northeasternmost Tennessee and also through eastern Pennsylvania into southeastern New York. Certain results of these investigations will be drawn upon along with those from separate work of the writer in

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eastern and especially central Pennsylvania, which has received the support of the Pennsylvania Geological Survey. In all the areas, numerous local sections have been measured and worked out in detail to provide an objective basis for understanding the deposits.

The present paper is devoted to the study of the Silurian and Lower Devonian formations of the northern part of the middle Appalachian region, embracing Maryland, Pennsylvania, New Jersey and southeastern New York.

Near Cumberland, western Maryland, the early Devonian, Silurian, and latest Ordovician include the following formations, given in descending order:

Lower Devonian:

Oriskany group:

Ridgeley sandstone, 130 feet
Shriver chert, 115 feet

Helderberg group:

Mandata shale, 20 feet
New Scotland limestone, 30 feet
Coeymans limestone, 10 feet

Silurian:

Keyser limestone, 280 feet (Silurian or Devonian)
Tonoloway limestone, 600 feet
Wills Creek shale, 500 feet
Bloomsburg beds, 20 feet
McKenzie shale and limestone, 300 feet

Clinton group:

Rochester shale, 30 feet
Keefer sandstone, 12 feet
Rose Hill shale, 600 feet

Tuscarora sandstone, 280 feet

Ordovician:

At top, Juniata red beds, 1000 feet, included in Silurian by some authors.

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The formations recognized in western Maryland have proven to be of wide extent through the middle Appalachian region. They nevertheless undergo striking lateral changes which will be briefly outlined.

The middle Appalachian Silurian beds reach their greatest thickness toward eastern Pennsylvania, where they become over 4,000 feet thick. In the latter area, they are formed primarily of Shawangunk conglomerate and sandstone below, and Bloomsburg red sandstone and shales above, together with a subordinate thickness at the top of Poxono Island shale, Bossardville limestone, and Keyser sandstone and limestone. As shown by interfingering of the deposits, the Shawangunk is an easterly phase which corresponds essentially in age to and laterally replaces the Tuscarora sandstone, Clinton shales, and apparently the lower part of the McKenzie beds of the more westerly area. The greatly thickened easterly Bloomsburg red beds similarly correspond to and replace the upper part of the McKenzie, together with the Wills Creek shale and probably some of the lower Tonoloway of western Maryland and central Pennsylvania. The Bossardville limestone at Schuylkill Haven, eastern Pennsylvania, contains ostracodes characteristic of the uppermost Tonoloway in parts of central Pennsylvania, while the Poxono Island shale presumably represents some of the middle part of the Tonoloway. The limits of the Keyser or Decker to Manlius beds of eastern Pennsylvania correspond rather closely to those of the Keyser of western Maryland.

Continuing northward from eastern Pennsylvania to the Helderberg escarpment of eastern New York, all but the topmost Silurian beds drop out rapidly by unconformity.

The Silurian beds thin southward from Maryland to Tennessee, with eventual disappearance by unconformity of the Keyser limestone and also of some of the median formations of the Silurian. As in Pennsylvania, the more easterly exposures tend to show replacement of marine by non-marine sediments, but the thicknesses are less.

The marine portions of the Silurian sequence are characterized

by well defined and comparatively widespread faunal zones. In part, these are based on brachiopods, but ostracodes have been especially valuable. The most important of the Silurian zones of the area are as follows:

Keyser limestone:

Zone of *Favosites praecedens* and *Meristella praenuntia*, with subzones of *Rensselaeria mutabilis*, *Tentaculites gyracanthus*, and *Spirifer vanuxemi;* also, in certain areas, with relatively persistent stromatoporoid and coral beds, the corals including *Cladopora rectilineata.*

Zone of *Chonetes jerseyensis*, with subzones of *Merista typa*, *Calymene camerata*, *Gypidula prognostica*, *Stenochisma deckerensis* and *Reticularia modesta. Cladopora rectilineata* occurs in some coral beds of rather wide extent. At base in central Pennsylvania is a persistent zone of *Leperditia scalaris.*

Tonoloway limestone:

At middle a widespread zone of *Hindella congregata*, overlapping in its lower part a zone of *Spirifer vanuxemi.* At top of Tonoloway in central Pennsylvania and in Bossardville at Schuylkill Haven is a zone of *Kloedenia centricornis* var. with the median lobe surmounted by a slender spine. *Welleria obliqua* is rather widespread in about the lower half of the formation. Other Ostracoda will also prove of zonal value.

Wills Creek shale:

Sparingly fossiliferous; locally in Maryland with a zone of *Spirifer vanuxemi* near middle; near base where Bloomsburg is thin occurs *Zygobeyrichia ventricornis.*

Bloomsburg red beds.

McKenzie shale and limestone:

Camarotoechia andrewsi and *Homeospira marylandica* are abundant in middle and upper parts; *Reticularia bicostata* is abundant in the *Beyrichia moodeyi* zone and often at

lower levels as well; *Orthoceras mackenzicum* occurs near the middle. The more restricted zones are as follows:

Kloedenella gibberosa zone
Kloedenella nitida zone
Beyrichia moodeyi zone, with recurrent *Kloedenia ventralis*
Barren beds
Kloedenia ventralis with profuse *Whitfieldella marylandica*
Schuchertella elegans—Kloedenella cornuta zone, with important Rochester shale elements, perhaps better classed as Rochester shale

Clinton group:

Rochester shale:

Drepanellina clarki—Dalmanites limulurus zone

Keefer sandstone:

Schuchertella subplana fauna in lower part in central Pennsylvania

Rose Hill shale:

Anoplotheca hemisphaerica below, replaced near top by *A. sulcata; Liocalymene clintoni* in middle and upper parts. *A. sulcata, L. clintoni, Chonetes* near *C. novascoticus* disappear abruptly at top. More restricted zones are as follows:

Mastigobolbina typus zone
Bonnemaia rudis zone
Mastigobolbina modesta zone, with *Zygosella postica*
Mastigobolbina lata zone
Zygobolbina emaciata zone
Zygobolba bimuralis zone
Zygobolba decora zone
Zygobolba anticostiensis zone

Castanea sandstone, in central Pennsylvania

Tuscarora sandstone:

With horizons of *Arthrophycus harlani* and of some eurypterids

Of the above zones, the greater number of those of the Keyser and Tonoloway were first established in Maryland by C. K. Swartz, and those of the Clinton by E. O. Ulrich and R. S. Basslers. Work on the McKenzie zonal ostracodes led to the writer's interesting discovery of the characteristic terminal dimorphic swellings of the Silurian Kloedenellidae.

The zones of *Spirifer vanuxemi* of the middle Wills Creek, middle Tonoloway, and upper Keyser represent recurrences controlled fundamentally by environmental relationships, and environmental factors affect all of the faunal assemblages. However, most of the zonation, and especially that of the ostracodes, involves primarily the evolutionary development and extinction of species and genera. Some of the zonal boundaries are particularly abrupt and may represent appreciable withdrawals of the sea. The top of the Rose Hill shale, for instance, is marked by the sudden disappearance, generally within one or two feet or less, of *Chonetes* near *C. novascoticus*, *Anoplotheca sulcata*, *Liocalymene clintoni*, *Mastigobolbina typus*, *M. triplicata*, *M. punctatus*, *Plethobolbina typicalis*, *Bonnemaia celsa*, *B. crassa*, *Zygosella vallata*, and *Dizygopleura loculata*. The extinction of the ostracode species involves the termination of the genera *Mastigobolbina*, *Bonnemaia*, and *Zygosella*, which provide many zonal species in the Rose Hill. An equally abrupt but less sweeping faunal change occurs at the top of the *Drepanellina clarki* zone, and the writer has been using this faunal boundary for the Rochester-McKenzie contact. A further change, not quite so sharply defined as seen in the field, but involving the disappearance of the last important Rochester shale faunal elements, takes place at the top of the *Schuchertella elegans-Kloedenella cornuta* zone.

The depositional relations of the *Schuchertella elegans-Kloedenella cornuta* zone present features of much interest. This zone is never more than 10 feet thick at localities where it has been measured. In view of this small thickness, together with the apparent, though evidently not long continued breaks, represented by the marked faunal changes at the base and top, it is surprising to find the zone persistently developed at section after

section from Danville and Williamsport, in northcentral Pennsylvania, southward into Virginia. Through this area of 10,000 to 15,000 square miles, the zone is not missing at any studied locality where the normal sequence across it is exposed for examination. The sediments of the zone are persistently calcareous shales with interbedded thin layers of limestone, the lower limestones tending to contain some fine quartz sand. Toward the east, the zone may be represented by more sandy phases, beyond the area where the fauna has been found. Toward the west, the zone disappears below younger beds at the Allegheny Front, and its actual western limits are unknown.

The next overlying zone, characterized by *Kloedenia ventralis* together with very profuse *Whitfieldella marylandica*, is coextensive with the *Schuchertella elegans* zone, and is comparable thereto in thickness and in geographic and lithologic persistence. Its upper limits intergrade with the next overlying generally barren beds, and the *Kloedenia* recurs in the still higher *Beyrichia moodeyi* zone.

Many of the other Silurian zones have greater geographic distribution, but, in general, are not quite so limited stratigraphically, and do not have such sharply marked, apparently disconformable boundaries.

The facies relations of the faunas of the area under consideration are of interest. The Tuscarora sandstone contains rather numerous horizons of the annelid burrows named *Arthrophycus harlani*, best seen as casts on under surfaces of sand beds deposited on burrow-marked clay interbeds. Some eurypterid "chowder" beds have been found in Pennsylvania to the westernmost belt of Tuscarora crop. Shelly faunas are notably absent. Similar faunal relations characterize the Shawangunk, including beds of Clinton as well as Tuscarora age.

The Rose Hill shales contain brachiopod-bearing beds often rich in individuals, but generally few in species except in limy beds near the top of the formation. Ostracodes are frequently profuse. Trilobites are moderately diversified. There are some pelecypods. Gastropods are few, although the pteropod-like

Tentaculites minutus is abundant on occasional bedding surfaces. Nautiloides have not been observed. Well preserved pelmatozoan cups are not found, although stem plates are common in some beds. The button-coral, *Paleocyclas rotuloides*, is locally common near the top, but otherwise corals are very rare, as are bryozoa. Conspicuously absent are the graptolites. Only one graptolite rhabdosome has been seen by the writer from the Rose Hill shale, and none from other Silurian beds of the Pennsylvania-Virginia region, although *Monograptus* is common in some Clinton beds in western New York.

The *Schuchertella subplana* fauna found in the Keefer sandstone in central Pennsylvana is relatively diversified, except for an interesting paucity of ostracodes. Ostracodes are again profuse in the *Drepanellina clarki* zone along with brachiopods and trilobites, and rarer bryozoa, pelecypods, and gastropods. The McKenzie formation is notable for limestone layers with profuse ostracodes, along with others with none, often suggesting current-concentrations of the little shells. Brachiopods are individually profuse in a good many beds but are generally rare in species. Pelecypods are locally abundant but as a rule poorly preserved. Near the middle of the formation, the gastropod *Hormotoma hopkinsi* abounds in occasional layers, and the cephalopod *Orthoceras mackenzicum* is common in a thin zone. Trilobites are almost wholly absent, except for a few in the *Schuchertella elegans* zone, and several specimens found in the upper McKenzie in Maryland. There are a few bryozoa. Occasional heads of the honeycomb coral, *Favosites*, are to be observed, apparently representing the Lockport species, *F. niagarensis*. Otherwise, corals are virtually absent, except in certain beds interfingering with the *Beyrichia moodeyi* zone near Lock Haven in northcentral Pennsylvania, and containing in profusion the Lockport *Cladopora multipora*. It is regrettable that these coralline beds are present only in a small area at the margin of the belt of Silurian outcrop, and that, farther northwest, they are buried below younger sediments and so can not be studied to obtain more critical evidence for or against the view that they represent a tongue from the Lockport

limestone of western New York. It is of interest that, like the Lockport, the actual coral-bearing beds at Lock Haven are themselves devoid, or nearly so, of the characteristic McKenzie ostracodes.

The Bloomsburg red beds lack known faunas, except for rare *Leperditias* in westward marginal phases. Near Loysville, Pennsylvania, a 20-foot red sandstone near the top of the Wills Creek, and believed to represent a tongue from the higher part of the more easterly, thicker Bloomsburg, contains numerous specimens of the ostracoderm fish, *Paleaspis americana*. However, these are not known to occur in the Bloomsburg proper.

The Wills Creek shales are rather sparingly fossiliferous, most of the beds being barren, or, at times, containing rather poorly preserved *Leperditias*. Fossils are common in some parts of the Tonoloway in Maryland and the Virginias, and the faunas there include elements which were thought at one time to suggest approximate equivalence of the Tonoloway to the Cobleskill to Manlius beds of central New York. Traced northward through central Pennsylvania, however, the Tonoloway becomes increasing depauperate, with loss of any faunal suggestion of relationship with the Cobleskill-Manlius deposits.

Deposition of the Keyser limestone brought with it a widespread return of profuse and diversified marine stromatoporoid, coralline, bryozoan, and brachiopod faunas. Crinoidal limestones are locally developed. Ostracodes are, at times, common, and trilobites occur. Northward persistence in the lower Keyser of the Cobleskill-occurring *Halysites aff. catenularia*, *Chonetes jerseyensis*, and *Calymene camerata*, as compared to disappearance of the marine assemblages in the Tonoloway, strongly supports the view that the lower Keyser is continuous with the Cobleskill of central New York; as does the close similarity and probable identity of the lower Keyser *Reticularia modesta* and variety *plicatus*, on the one hand, and the Cobleskill *R. corallinensis* on the other. The upper Keyser *Spirifer vanuxemi-Tentaculites gyracanthus* faunas are likewise suggestive of the New York-Manlius limestone.

In the sense that the Cobleskill to Manlius beds of central

New York have long been classed as Silurian, the Keyser can also be so regarded. Actual correlation to Silurian and non-equivalence with earliest Devonian deposits of England and Europe are by no means established, and, in this sense, classification of the Keyser remains an open question. Diastrophically and paleogeographically, the Keyser represents the return of open seas to the middle Appalachian region, following a period of more restricted oceanic connections during Wills Creek and Tonoloway deposition; thus inaugurating conditions which continued through the Helderberg and Oriskany of the Lower Devonian.

The lower as well as the upper boundary of the Appalachian Silurian has been subject to discussion. Relations of the Tuscarora to the underlying Juniata have been considered in central Pennsylvania, with investigation of numerous sections and the attempt to recognize and correlate subdivisions of the Juniata deposits. Whatever else is true, it is clear that the Tuscarora—Shawangunk beds widely transgress the Juniata deposits, and that marked geographic changes occurred from Juniata to Tuscarora time. On the other hand, extensive occurrence of pebble beds at the base of the Juniata in central Pennsylvania suggests that the acme of Taconic uplift was then attained. The diastrophic history is complex, and, in the writer's opinion, is of questionable value, except in a very general way, as a criterion for correlation in terms of the Siluro-Ordovician boundary as seen in England.

Turning briefly to the Lower Devonian, the *Gypidula coeymanensis* and *Eospirifer macropleurus* faunas of the Helderbergian Coeymans and New Scotland limestones, and the *Spirifer arenosus* fauna of the Oriskany proper, are widespread through the middle Appalachian region, furnishing excellent correlations of the deposits in which they are found. Relationships of the Shriver chert, lying between the *macropleurus*- and *arenosus*-bearing beds in western Maryland and central Pennsylvania, have been more troublesome; but are now being clarified by studies of Lower Devonian ostracodes, especially those of the family Thlipsuridae. The ostracode assemblage of the Shriver of western Maryland has been duplicated in collections provided by Chadwick from the

lower part of the Oriskanian Glenerie limestone at Alsen, New York; but has not been discovered in central Pennsylvania, where the middle to upper Shriver, as there seen, contains a related but younger ostracode fauna, close to that of the lower Glenerie at Kingston, New York. The Port Ewen at Kingston, New York, and at the Delaware Water Gap, Pennsylvania, contains a third related but distinct set of ostracodes, older than that of the Shriver of Maryland, and this assemblage also occurs in Mandata beds in Perry County, Pennsylvania. Additional and distinct ostracode assemblages have been obtained from Glenerie beds near Catskill, New York, and from questionable Mandata beds at Warren Point, Pennsylvania. The facts that the western Maryland Shriver ostracodes occur in the Glenerie at Alsen, and that the Port Ewen species persist into the Mandata of Perry County, do much to show that these assemblages have zonal time value, and that they are not simply provincial in significance, as seemed possible at an earlier stage of their study. Ostracodes have also been obtained from the Middle Devonian Onondaga beds of central Pennsylvania and northeastern West Virginia, and again show marked zonal values.

Work on the ostracodes of the Shriver of central Pennsylvania has led to discovery of fine trilobites and conularids, providing some interesting information on several of their structural aspects, especially in the case of the Lower Devonian dalmanitid trilobites.

In summary, the Silurian deposits of the middle Appalachian region comprise a sequence of dominantly clastic materials, which reach a maximum thickness of about 4000 feet. The clastics become coarser and in considerable part continental toward the east; especially toward eastern Pennsylvania where, for the most part, they are formed by the Shawangunk conglomerate below, and Bloomsburg red beds above. By these changes, the clastics show clearly their derivation from the easterly oldland Appalachia.

The sedimentary facies necessarily show varying geographic distributions; but these are variations within deposits of, at any one time, one geographically continuous basin of deposition, and

there is no known evidence within the area of study that the basin was at any time subdivided by arches such as were developed in some parts of the Appalachian region during Ordovician time.

There are significant changes in thicknesses of the sediments. Thus, the marked thickening of the clastics toward eastern Pennsylvania strongly suggests that they were there fed by a major river system or systems issuing westward from the well watered source land. Presumably, the Bloomsburg was in large part deposited directly by fluvial waters. Portions of the Shawangunk —Tuscarora materials may have been spread in shallow brackish waters, but, in any event, lack the shelly faunas which might be expected had the shallow waters been truly marine.

The thickness changes are significant but not rapid. Maximum convergence angles are about one degree. Commonly, the angles of convergence of upper and lower surfaces of sediments of one age are to be measured in a few minutes or seconds of arc or less. Such rate of thickness changes of the suspension-borne sands and clays argues that the currents were relatively active and were, in general, spreading the materials over a comparatively flat platform, mostly in shallow marine waters, but, in part, in lagoonal and alluvial areas. The deposits of the *Schuchertella elegans* zone appear to be an extreme example of deposition over a flat platform covered by a shallow sea inundating an extensive area, during a geologically brief time period.

The finely marked faunal zones, in general, involved either rapid evolutionary change of the concerned faunal elements, or slowness of deposition of the sediments, or, very likely, both. Comparatively wide distribution of the clastics would tend to thin them at any one place.

The faunas show clear environmental relationships, and, in general, the shelly assemblages are such as would live in shallow reaches of the sea, mostly with the waters not continuously clear, and perhaps a little brackish. Through most of Silurian time coralline faunas are inconspicuous, though they were comparatively prominent during early to middle parts of the period toward Indiana, Illinois, and Ontario. They are but sparsely and locally

present in the McKenzie, and are extensive only in the Keyser limestone. The planktonic graptolites are notable for their absence, and nautiloides are common at only a few horizons. The facies relations of the faunas must be given due regard in considering correlations with other areas.

The distributions and relations of the sediments and faunas of the area of study are thus quite unlike those pictured by Jones for the Silurian of England, where he envisions a moderately deep geosynclinal area with thin axial clays, thickening into coarser, poorly washed, submarginal, clayey sands, and with thin and discontinuous well washed sands, clays, and limes forming in shallow shelf waters; the shelf areas inhabited by shelly faunas, giving place to graptolites toward the axis of the geosyncline. Perhaps it would be better to say that the marine beds of the Silurian of the middle Appalachian area of crop are essentially comparable to the shelf-sea deposits of the English area, and that the prime differences rest in the far wider distribution, greater continuity, and greater thicknesses of this facies, combined with lack of the deeper water sediments, and the presence in Pennsylvania, especially, of a great body of continental red beds which find no counterpart within the English Silurian.

Publications

Hall, James

1852. *Description of the organic remains of the Lower Middle Division of the New York System.* Pal. N. Y. **2:** 362, 85 pl.

Jones, C. T.

1938. *On the evolution of a geosyncline.* Quart. Jour. Geol. Soc. London. **94:** lx-cx.

Swartz, C. K., Prouty, W. F., Ulrich, E. O., & Bassler, R. S.

1923. *Silurian.* Md. Geol. Survey, 793 pp., 67 pl.

Swartz, C. K., & Swartz, F. M.

1929. *Silurian of the central Appalachians* (abstract). Bull. Geol. Soc. Am. **40:** 112, 113.

1930. *Age of the Shawangunk conglomerate of eastern New York.* Am. Jour. Sci. (5) **20:** 467–474.

1931. *Early Silurian and Early Devonian formations of southeastern Pennsylvania.* Bull. Geol. Soc. Am. **42:** 621–662.

1941. *Late Silurian and Early Devonian formations of southeastern Pennsylvania.* Bull. Geol. Soc. Am. **52:** 1129–1192.

Swartz, F. M.

1929. *The Helderberg group of parts of West Virginia and Virginia.* U. S. Geol. Survey. Prof. Paper **158:** 27–75, 4 pl. (Includes discussion of Keyser limestone.)

1932. *Revision of the ostracode family Thlipsuridae, with descriptions of new species from the Lower Devonian of Pennsylvania.* Jour. Pal. **6:** 36–58, pl. 10, 11.

1933. *Dimorphism and orientation in ostracodes of the family Kloedenellidae from the Silurian of central Pennsylvania.* Jour. Pal. **7:** 231–260, 4 pl.

1934. *Silurian sections near Mount Union, central Pennsylvania.* Bull. Geol. Soc. Am. **45:** 81–134.

1935. *Relations of the Silurian Rochester and McKenzie formations near Cumberland, Maryland, and Lakemont, Pennsylvania.* Bull. Geol. Soc. Am. **46:** 1165–1194.

1935a. *Silurian sections in northcentral Pennsylvania* (abstract). Geol. Soc. Am., Proc. for **1934:** 114.

1936. *Revision of the Primitiidae and Beyrichiidae, with new Ostracoda from the Lower Devonian of Pennsylvania.* Jour. Pal. **10:** 541–586, 12 pl.

1938. *Ostracoda from the Lower Devonian of eastern New York and Pennsylvania* (abstract). Bull. Geol. Soc. Am. **49:** 1902–1903.

1939. *Silurian System (in the Tyrone quadrangle).* Penna. Geol. Survey. (4) (Atlas of Pennsylvania) No. **96:** 29–56.

1939a. *The Keyser limestone and Helderberg group,* in *The Devonian of Pennsylvania.* Penna. Geol. Survey. (4) Bull. G. **19:** 29–91, 383–394, pl. 1–9.

Swartz, F. M. & Swain, F. M.

1941. *Ostracodes of the Middle Devonian Onondaga beds of central Pennsylvania.* Bull. Geol. Soc. Am. **52:** 381–458, 8 pl.

SECTION OF BIOLOGY

MARCH 9, 1942

DOCTOR EARL H. MYERS, Woods Hole Oceanographic Institute, Woods Hole, Massachusetts: *Biology of the Foraminifera and Their Significance in Paleoecology.* (This lecture was illustrated with lantern slides and a motion picture on the life cycle of *Patellina corrugata* Will.)

Foraminifera have probably inhabited all oceans capable of supporting life. This is evident from the universal distribution of the tests in marine sediments both recent and geologic. The extent of their distribution can be appreciated when we recall that approximately 70% of the earth's surface is covered by the sea and that 70% of all land areas are overlaid by rocks of marine origin. Therefore, approximately 90% of the surface of the earth either is or has been the natural habitat of these marine rhizopods. This is true because these organisms live at all depths on the floor of the sea and in the overlying water.

Globigerina ooze, consisting largely of the tests of pelagic species now forming on the floor of the sea, covers an area that is approximately equal to 25% of the earth's surface. Little is known at this time concerning how numerous these organisms are in the sea, the rate at which they are contributed to the sediments, or the sequence of events in the life history. It has been presumed that these species are pelagic at all times, but the fact that many of those most abundantly represented in *Globigerina* ooze are seldom taken in plankton hauls, suggests otherwise.

Recent studies on the life cycle of *Tretomphalus bulloides* show how a typically benthonic or bottom dwelling foraminifer may develop a pelagic phase. From cultures, we have determined that *Tretomphalus* gives rise to sexual gametes which unite in fertilization to produce a zygotic amoebula. This develops into the multinucleate microspheric phase of the life cycle often re-

ferred to as *Discorbis isabellina*. *D. isabellina* asexually produces mononucleate megalospheric individuals that are commonly referred to as *D. concinnus*. Upon reaching the growth limit for this phase of the life cycle, the individual develops a large gas-filled float enclosed within a float chamber. This Tretomphalus stage rises to the surface of the sea where it extends filose pseudopodia in all directions beneath the surface film of the water. Should the pseudopodia of two individuals come into contact, they anastomose, thicken, and draw the two tests together, in such a manner that the gametes, streaming through large openings in the tests, which are now approximately opposed, have a maximum opportunity to unite in fertilization. This is perhaps one of the most remarkable adaptations of a species to assure the fertilization of the gametes and the dispersal of sexual products to be found in the animal kingdom. The genus *Tretomphalus* belongs to the family *Cymbaloporettidae*, while *Discorbis* belongs to the family *Rotaliidae*. Therefore, this work conclusively demonstrates that the three species of the two genera mentioned are actually different phases in a single life cycle.

A second method of association of sexual individuals, which assures a maximum opportunity for the fertilization of the gametes, was observed in several other species of *Discorbis*. In *D. opercularis*, two or more mononucleate megalospheric individuals associate in such a manner that the several tests fuse. Following gametogenesis, the gametes derived from the several individuals are free to mingle within the brood chamber formed by the several tests. The zygotic amoebulae, which result from the union of gametes in fertilization, utilize unsuccessful gametes as food. This results in growth, so that the diameter of the initial chamber of a multinucleate microspheric individual is about equal in size to that of the mononucleate megalospheric individual.

In the sexual phase of the life cycle of *Spirillina vivipara*, a somewhat similar method of reproduction occurs. In this species, the several tests do not fuse, but remain in a horizontal position upon the substratum and become enclosed in a common cyst composed of diatom frustules and other debris held together by animal

cement. It would seem that, in this and other species in which there is an association of individuals prior to gametogenesis, a chemical activator stimulates the several individuals, so that subsequent activity, including nuclear division and multiple fission, takes place at about the same time. This is further suggested by the fact that, when a microspheric individual which normally reproduces asexually, becomes enclosed within a cyst containing several megalospheric individuals about to reproduce sexually, the microspheric individual produces gametes in place of megalospheric juveniles.

In the life cycle of *Elphidium crispum*, the flagellated gametes are pelagic and there is no evidence that megalospheric individuals associate prior to gametogenesis. As a result, fewer gametes become fertilized, and the ratio of microspheric to megalospheric tests is far less than in species in which such an association takes place.

From a statistical study of populations in the sea, it was found that the life span of *E. crispum* is usually one year; and the life cycle, including a sexual and an asexual phase, requires at least two years. Under tropical conditions, it was found that the time required to complete the life cycle is reduced to one year. The life cycle of smaller species usually requires not less than six weeks to two months. Percentage frequency distribution curves for samples of populations of *E. crispum*, taken monthly for twelve months, show that growth and reproduction are limited to the colder spring months while winter dormancy sets in at a time when the water temperatures in the sea are relatively high. The food of the foraminifera, as determined from cytoplasmic inclusions and feeding experiments, consists largely of unicellular plants, and, as might be expected, those conditions in the sea, which influence phytoplankton production, indirectly influence the productivity of the foraminifera. Populations of foraminifera on the floor of the sea number from a few, to tens of thousands of individuals per square foot. *E. crispum* often exceeds 1,000 individuals per square foot, while the larger tropical species *Tinoporous* may number in excess of 100,000 individuals per square foot, on a bottom

covered by a sparse growth of algae. The marked influence of slight variations in bottom sediments, food, temperature, salinity, depth, and other conditions, upon the species occurring in populations; the persistent nature of the calcareous tests in the sediments; and the changes in species that have taken place with the passing of time, make the foraminifera a useful guide to the stratigrapher, especially in petroleum geology, and to the paleoecologist, in his attempt to reconstruct the biotic conditions in geological horizon.

New methods for obtaining samples of surface sediments from the floor of the sea and the determination of populations from protoplasmic casts that remain after the sample has been treated with acid, should contribute much to our knowledge of the role of these marine rhizopods in the economy of the sea.

SECTION OF PSYCHOLOGY

March 16, 1942

Doctor B. Roger Philip, Fordham University, New York, N. Y.: *Some Factors in the Discrimination of Color Mass.* (This lecture was illustrated by lantern slides.)

Psychologists have frequently called attention to the complexity of the judgment process and have enumerated factors such as those which occur in space and time errors, contrast effects in judgment, and the series effect, to mention but a few, which exert small but significant influences on psychophysical thresholds. This paper considers the influence of certain cues based upon the knowledge of previous judgments in discriminations near the threshold. It investigates tendencies after a judgment has been made to alternate the response when the subsequent stimulus is presented; or, on the other hand, to repeat the response previously made when the subsequent stimulus is presented. In addition, it investigates the tendency of the subject to make errors in sequence when disturbed by the possibility that an error has just been committed.

The material of this experiment is similar to that which has been used in previous work of the author to study the discrimination of color mass. It consists of a series of cards, on each of which is a number of dots printed in two colors, Blue (B) and Purple (P), one of which predominates. The subject is told to judge the predominating color merely by the mass effect and without counting the number of dots. The sequences in which the stimuli were given are of importance for this study. The stimuli were given in a random order subject to the following limitations: First, in every group of 20 stimuli there was an equal number of B's and P's. Secondly, there were no more than 4 consecutive stimuli of the same type. Hence the stimuli could be alternated in the sequence BPBP, or PBPBPB, etc. or they could be repeated in doublets, triplets and quadruplets, e.g., BB, PPP or BBBB.

The primary interest of this study was to compare the tendency to alternate a previous judgment with the tendency to repeat that judgment. Thus, if the response B were given at any point in the test, an alternative response for the next stimulus would be P, and a repetitive response would be B. The repetitive type of response was first investigated. A tabulation was made for both color stimuli of the errors at each position of the doublets, triplets, and quadruplets, and of the first position immediately following these types. From a tabulation of the results, it is obvious that the percentage of error rises continuously with position throughout the doublet, triplet and quadruplet, and immediately drops when the stimulus is changed. That this increase in error is significant is shown by the fact that the critical ratios are all significant.

It must be remembered that these judgments are difficult to make, and, for the most part, are in the neighborhood of the discriminatory threshold. Even when correctly made, they are seldom accompanied by any great degree of assurance. To aid him in his judgment, the subject is eager to grasp additional cues, the influence of which is out of proportion to the precision with which they may be perceived. Furthermore, a form of the stimulus error is present. Rather than base his judgments on completely objective criteria, the subject tends to discriminate the stimuli, in part at least, by what he imagines they might be, even before they are presented. In other terms, he tends to anticipate the stimuli on the basis of some kind of probability. In the course of the experimental session, he becomes indirectly aware of the relative frequency of occurrence of doublets, triplets, quadruplets and of the alternative forms. He does not estimate this frequency in numbers, and if asked to do so, would probably be considerably in error. Nevertheless, his judgments are subtly influenced by this vague statistical knowledge. Of importance, too, is the fact that his subsequent judgments are influenced by his prior judgments. In other terms, he feels that having made a judgment on a stimulus of a certain type, the probability of occurrence of these stimuli will thereby be lessened. In reality, of course the selection of the stimulus that will be presented is, in large part, independent

of previous selections, being determined only by the conditions outlined above.

As a consequence of his lack of confidence in these difficult judgments and of his tendency to use some type of probability as an aid in framing his judgments, he is prone to render a judgment counter to his discriminatory ability. His subjective attitude is antagonistic to his objective judgment. In short, while his real discriminatory ability does not change with position, his tendency to alter his judgments in repetitive types of stimuli does increase with position to the detriment of his accuracy.

In the study of the alternative types, a tabulation was also made of the errors at each position of the alternation, and also of the first position immediately following, i.e., of the first response of the doublet, triplet or quadruplet, which follows the alternation. The most interesting fact observed is that the first three positions of the alternation curve very closely resemble the form of the doublet curve. In the repetitive type of stimuli we found a clear-cut relationship between position and percentage of error — the error percentages increasing steadily with position. Hence, in the alternative type of stimuli, one might be prone to expect maxima and minima to alternate with position. Obviously this is not so. Even where an alternation does occur (in the first three positions), it is rather contrary to what one might assume from the findings of the repetitive type of stimuli. There, errors increase with position because the subject tends to *change* his judgement. The rise in error percentage at the second position and the drop in the third position in the alternation type implies that he tends to *repeat* his judgment, at least for the first three positions.

Furthermore, if, on the curve of error, percentage with position there is also plotted for comparison sake, a curve showing the number of alternations which terminate at the various positions, it can readily be noted that the general trend of both curves is similar. This fact probably implies that in the case of the alternative, as in the case of the repetitive type of stimuli, the subject becomes vaguely aware of the experimental frequency of

the sequence types, and sometimes attempts to adjust his judgments to this knowledge, rather than to discriminate solely on the basis of the color mass of the stimuli. In other terms, the indirect cues that he obtains from his experience with the experimental set-up detrimentally affect his judgment, impelling him to go counter to his judgment based on discriminatory ability. This impulse is the more urgent with a consequent increase in error the longer a series continues. At times, indeed, this impulse may bring greater accuracy,—whenever his tendency to anticipate the sequence of the stimuli coincides with their actual sequence; e.g., when the stimuli are changed after a repetitive type.

What is apparent, then, is not so much that there is a conflict between an alternative tendency and a repetitive tendency in making a judgment, as an attempt to utilize a vague statistical knowledge of the sequence arrangement as a cue in framing the judgments. Cues thus obtained are often at variance with the judgments based on discriminatory ability, and progressive increases of error percentage with position arise from resultant tendencies to alternate when repetitions are required, and to repeat when alternations are required.

In the course of the experimentation, it was noticed that subjects sometimes became emotionally disturbed when making their judgments. These disturbances, chiefly noted in the harder series, seemed to cause sequences of errors. In an attempt to analyze the tendency to repeat errors, a tabulation was compiled of the frequencies of errors, one at a time, two at a time, etc., made by every subject in each series.

The X^2 test was used to determine the conformity of the experimentally found values with the calculated values of a Poisson series of best fit. The corresponding p values were also calculated. The conformity of the Poisson series is best in the easier series and there is no significant agreement in the hardest series. It may be noted that individual errors occur less frequently, and that sequences of two, three, four, etc. errors occur much more frequently than chance expectancy, as given by the Poisson series. The probable explanation for this divergence, in

part at least, is that the subject becomes confused when making difficult judgments, loses confidence in his discriminatory ability especially when he has made an error, and hence tends to make two or more errors in sequence.

The results of this investigation seem to be in line with several others which have uncovered kindred effects in the influence of an unformulated knowledge of the experimental set-up as a cue in determining the response and have been interpreted on the basis of the principle of expectancy. Stated in other terms, this investigation, as well as those which are concerned with similar phenomena, is an attempt to study the adjustment of the response to the supposed probability of occurrence of the stimuli.

Distinction should be made between situations in which a discrimination can be made and where there is no guessing, and situations which evoke pure guesses, where the stimuli are presented only after the corresponding response has been made, or there is no objective means of making a correct judgment. The initial runs of mazes, and random matching experiments, are illustrations of the latter type; ordinary psychophysical experiments, of the former. Even in psychophysical discrimination, the probability factor, however, may come into play sooner or later, after the subject acquires some knowledge (not necessarily formulated) of the experimental set-up, which is used in an attempt to anticipate the stimuli. The alternative and repetitive tendencies which we have described, the expectations of the stimuli in conditioning, the patterns of response in psychophysics and parapsychology described by Goodfellow, and the ambiguous cues of Brunswik, alike fit, to a greater or less degree, in this category. In all of them, the cues for response are antecedent to the stimuli about to be presented, but are derived from, and are, hence, subsequent to other stimuli and responses.

The tendency that we have noted, in a subject to make errors in sequence when confused and disturbed, on the other hand, is due to his knowledge of responses already made, without significant reference to stimuli about to be presented. In this regard, it resembles the contrast effect described by Fernberger, Arons and

Irwin, and Preston, the series effect, and those effects which cause space and time errors. There is this difference,—the effects just enumerated are due, in part, to an absorption of the immediate stimuli into a frame of reference which alters their stimulus value. The tendency to make errors in sequence is the result of a minor emotional disturbance, whose effect on the stimulus is to increase its difficulty, by rendering less precise its corresponding frames of reference.

In the course of other experiments, where the ranking method was used with the same type of material, several factors in the discrimination process were clearly noted. They are merely summarized here, the data upon which the conclusions are based are given elsewhere.

1. In the discrimination process, there is quickly established a standard, a frame of reference from which judgments are based, which may be (a) general and remote, due to past experience; or (b) particular and proximate, originating within the experimental series.

2. This standard is subject to disintegration and interaction. Hence originate the time errors which reflect the distortion of the judgments from the standard as indicated by the skewness of their frequency curves.

3. Serial effects, whose strength is a function of their deviation from the frames of reference, depend upon inhibitory influences of neighboring stimuli, and, in turn, cause variation in the accuracy of the serial judgments.

4. Generalization effects, which have an exponential gradient, indicate the spread of erroneous choices to surrounding stimuli. The similarity of the stimuli and the difficulty of the task make for inhibition with a consequent diminution in the discrimination and an increase in the generalization.

5. Variations in the attitude or set, which is a powerful factor in selective discrimination, cause variations in the frame of reference and distortions in the judgment.

6. The principle of expectancy may be used to explain anticipatory and repetitive tendencies, based upon a vague, sub-

liminal awareness of the relative frequencies of the various stimuli.

7. Emotional upsets, when the subject becomes uncertain of his judgments and has the feeling of having made an error, diminish the discriminatory ability and are the basic cause of sequences of error beyond normal chance expectancy.

SECTION OF ANTHROPOLOGY

MARCH 23, 1942

DOCTOR CONRAD M. ARENSBERG, Brooklyn College, New York, N. Y.: *Irish Rural Social Organization.*

The problem presented by the statistics of population in the Irish Free State offers an excellent example of the way in which the techniques of field-study and interpretation of custom, developed first among primitive peoples in social or "cultural" anthropology, can be used profitably to gain an understanding of economic and social phenomena in the more complex societies of contemporary civilization.

Irish demography presents a picture of conditions unique in the civilized world. The population has declined from eight million in the year of the first census, 1841, before the Great Famine, to a mere three million in 1941. Along with this decline, has gone a steady rise in the average age of first marriage, until now, in Ireland, men and women marry at a later date than anywhere else. In addition, the proportion of those who escape marriage altogether has risen progressively, until today more of the men and women of all ages remain celibate in Ireland than in any other country for which we have adequate records.

Such a situation presents an intriguing problem in the interpretation of human custom, and in the adaptation to customs of human beings. It is not a biological or nutritional matter. Once marriages do take place in Ireland, they are as fecund as among other human races. Furthermore, there seems to be no likelihood of a decline of population among the people of Irish descent transplanted overseas. In fact, this demographical picture has included another characteristic facet until the outbreak of World War II. Though emigration did not sustain the immense volume it showed during and just after the Famine years, it has maintained a steady flow for over a hundred and fifty years, playing its part all through the rise of the conditions just described.

The usual explanation, upon which many schemes of remedial action and governmental intervention, both British and native, have been based, is that such demographic conditions must be the result of chronic, endemic poverty. The first hypothesis that springs to mind is that human beings forego matrimony and parenthood so long, and in such numbers, only when they must.

But the records soon demonstrate that such demographic conditions do not spring directly from economic causes. In the first place, the conditions are characteristic of the small farmers, peasants, who, while not the most prosperous of Irishmen, are not the poorest class in the land. The landless laborers, particularly of the towns, chronically unemployed and on relief, show no such delay in marriage and widespread celibacy.

Furthermore, the characteristic conditions have been steadily on the increase during the same hundred years that has brought the level of living, savings, and economic success among the small farmers of Ireland from the nadir of the Famine to its highest recorded state. The conditions are earmarks, not of poverty, but of progressive prosperity.

Another easy explanation used to run, before the establishment of the Free State and self-government, that these conditions arose out of a flight from intolerable conditions at home. Yet the same trends persist through the whole period and show no change whatsoever corresponding to the shift from foreign to native rule. Indeed, both governments persisted in treating the problem as an economic one and adopted many palliative measures. The remedies proved equally useless, regardless of their origin at home or abroad.

Nor could the explanation be any lack of opportunity for life careers. For the period of the growth of these demographic conditions was also the period of the emancipations of the Catholics, the throwing open of professional, mercantile and civil service posts to the sons and daughters of the local farming population, and the filling up of these walks of life—till 1870 reserved for the sons of the Protestant and "English" Ascendancy (i.e., the descendants of the Cromwellian colonists became landlord aristocrats),

with Catholic "Irishry." The demographic figures correlate not with restricted opportunity, but with an open class system and the existence of *carrières ouvertes aux talents.*

In the course of the Harvard Expeditions in Ireland, in the years 1932–1935, it was felt that this problem of population warranted special attention from the members of the expeditions conducting social-anthropological research into present social life, as distinct from those conducting archeological and somatological research. But it was not until a thorough exploration of local custom and social organization was completed among the small farming population in the areas of the country where relatively more of the ancient tradition survives, that a satisfactory interpretation began to appear. The possibility of correlating statistical indices for the whole country soon became clear from the results of participant observation, interviewing and case study, and community structure analysis in the field.

Irish rural life is based upon the individual-family farm (Meissner's *Einzelhof*), an ancient "Celtic" or West-European form of land-settlement. Today, as in many parts of the United States, these single-family farms are self-sufficient economic units. Practising a mixed, in this case, primarily pastoral economy, the united efforts of a man, his wife, perhaps a sibling of either, and their children of both sexes and all ages, support a single household from the produce of milk cattle and a potato garden. The household enters the stream of commerce only to dispose of its annual surplus of calves (which become the beef cattle Ireland supplies the English table), milk, and eggs. Even where, as often today, clothing, wheat-flour, tea and sugar are bought in the market towns, the outline of family self-subsistence remains little changed.

Such a basis of subsistence economy in individual family households, each one very much a duplicate of the other, puts a very definite imprint upon community life. The principal differences in status (within the peasant class) depend very largely on age-grading, in which the members of an older generation are farm family heads, men and women "of the house." All others, the young, the landless, and the few followers of rural trades,

supplying the farm families locally, but without farms of their own, are grouped together in the community as "boys" and "girls," inferior in status. Tradition, folklore, and supernatural belief, as, for example, an identification between the misnamed "fairies" and the dead ("old men and women"), support this stratification of the community upon the basis of age. Fundamentally, of course, it is to be traced directly into household and family economy, where the "old man" and "old woman" direct and control the united efforts of the self-subsistent group.

Ties between the self-subsistent family units, other than the links of common position among the family heads, namely, the "old people," depend, then, upon the solidarities originally established among brothers and sisters, as boys and girls in the united family enterprise. In the transition from generation to generation, these boys and girls are dispersed from the original household through emigration, movement into town occupations, or out-marriage. What cooperation exists in agriculture, and nearly all the ties of mutual aid and obligation between families, thus follow these ties. "Friendship," as the bonds between cousins of first, second, and third degree are called, remains the most complete, and, in many instances, the only basis of any contact and solidarity between families. As such "friendship" depends upon common descent, its existence supports the misimpression that the "clan" continues to exist in Ireland. Actually, the patronymic line is only one, though symbolically the most important one, of the lines of common descent, which unite the "friends" or cousins of the same generation of the bilateral kinship group. The long-continued occupance of the land by a single family, and the inheritance of family holdings by single heirs (nowadays, the usual practise), have identified blood relationship and membership in social groups, occupations, and a community, to a point where kinship ties outweigh any others.

As a result, an exaggeration of the European stem-family or *famille-souche*, first described by LePlay, has appeared. The setting up of the new household of the heir comes to involve a marriage, which introduces a bride to become the new "woman of

the house," and which disperses the remaining children who do not inherit. Such a marriage, known locally as "making a match," exchanges a farm inherited by the groom for a "fortune" or dowry supplied by the bride. In the exchange, a complete transformation of the relationships and statuses of all the household members takes place and is provided for. The former family heads, father and mother of the heir, retire from active command, move into the status of "old people," and divide up all the surplus accumulated by the united efforts of the family (beyond the farm and its capital, which go to the heir) into "fortunes" providing dowries for daughters and starts-in-life, such as fees for professional training, apprenticeship, or emigration, for sons. Since such provision occurs only at the match, or in immediate anticipation of it, the marriage of an heir comes to be the most crucial point of family transition, and one in which all the life-interests of the corporate family group are served. Again, since local prestige depends upon one's family's "land," and since the size of the provision made for children is related and equated to the return of labor from the "land," the success with which such a transition is effected also becomes a chief source of prestige. Since emigrants into the towns or overseas occupations (education for which is so painfully paid for in the efforts of the whole family at home) are all dispersed brothers and sisters bound to the parents and the heir at home by the ties of "friendship" or kinship, which alone allow mutual aid, solidarity, and common prestige, a successful dispersion of the family members, in anticipation of transmitting a farm to an heir and his bride, brings direct and prolonged advantages to the kinship group at large, and to the individual-family reestablished on the home farm.

Around such a nucleus of family transition, reformation, dispersal, and creation of extended kinship obligations, all involved in match-making marriage, a great deal of local custom and community life revolves. Marriage becomes the central focus of both individual and group sentiment and aspiration, and it becomes very much indeed a transition in corporate existence in rural Ireland. That marriages should be so long delayed, and so rare

in a rural social organization where only an heir can marry, and then only when a family is successfully and advantageously dispersed, turns out, then, no longer to be surprising.

In the light of such knowledge, indeed, it can be seen, at once, why celibacy and delayed marriage in the rural population of Ireland have become a concomitant of prosperity, not poverty. The demographic conditions represent the reaction of an ancient familial system of social organization to the opening up of bourgeois, middle-class occupations, requiring the considerable preparation and education which could only be brought by the surpluses accumulated by an entire working household, to the sons and daughters of small farmers trained in the ancient tradition. New economic conditions and new opportunities in middle-class life did not transform the old Irish family system. The family system adapted itself to the new conditions and the new opportunities. Late marriage and a high proportion of celibates are the indices of that adaptation. They mark the scramble for better jobs, for higher positions in life, and for superior opportunities for dispersed children, to which the new conditions lead. The anthropological evidence is that changing economies do not transform custom. On the contrary, custom persists and forces economic change to conform to its mold.

SECTION OF OCEANOGRAPHY AND METEOROLOGY

MARCH 6 AND 7, 1942

Conference on "*Boundary Layer Problems in the Atmosphere and Ocean.*"

The new Section of Oceanography and Meteorology started with a Conference on "Boundary Layer Problems in the Atmosphere and Ocean," the first of a projected series. Doctor C. G. Rossby, Institute of Meteorology, University of Chicago, Chicago, Illinois, was the Conference Chairman in charge of the meeting.

The program consisted of the following papers:

"Introductory Address," by C. G. Rossby.

"On the Ratio Between Heat Conducted from the Sea Surface and Heat Used for Evaporation," by H. U. Sverdrup, Director, The Scripps Institution of Oceanography.

"Evaporation from Land Surfaces," by B. Holzman, U. S. Weather Bureau.

"Turbulence and the Transport of Sand and Silt by Wind," by Anton A. Kalinske, Iowa Institute of Hydraulic Research, University of Iowa.

'Sources of Atmospheric Heat and Moisture over the North Pacific and North Atlantic Oceans," by Woodrow C. Jacobs, U. S. Weather Bureau.

"The Effect of a Gradual Wind Change on the Stability of Waves," by B. Haurwitz, Massachusetts Institute of Technology.

"Boundary Layer Problems Involved in Snow-Melt," by Phillip Light, U. S. Weather Bureau.

"Generalization for Cylinders of Prandtl's Linear Assumption for Mixing Length," by R. B. Montgomery, New York University.

SECTION OF PHYSICS AND CHEMISTRY

MARCH 27 AND 28, 1942

Conference on "*Color, Constitution and Reactions of Dyes.*"

The Section of Physics and Chemistry held a Conference on "Color, Constitution and Reactions of Dyes," as the fourth in the series for the Academic Year of 1941–1942. Professor Victor K. LaMer, Columbia University, New York, N. Y., was the Conference Chairman in charge of the meeting.

The program consisted of the following papers:

"Introduction," by Victor K. LaMer.

"Absorption and Resonance in Dyes," by L. G. S. Brooker and collaborators, Eastman Kodak Company.

"Theoretical Discussion of the Absorption of Polymethine Dyes," by A. L. Sklar, Catholic University.

"Ultraviolet Absorption of Organic Molecules," by W. H. Rodebush, University of Illinois.

"Influence of Position of Substitution on the Absorption Spectra of Isomeric Dyes," by Wallace R. Brode, Ohio State University.

"Photooxidation, Photoreduction and Photogalvanic Effect of Dyes," by E. Rabinowitch, Massachusetts Institute of Technology.

"Kinetics of Carbinol Formation in Triphenyl Methane Dyes," by Seymore Hochberg, Marion Barnes and Victor L. LaMer, Columbia University.

"Regeneration of Alkali Faded Brom Phenol Blue in HCl Solutions," by E. S. Amis, Louisiana State University.

NEW MEMBERS

Elected March 26, 1942

ACTIVE MEMBERSHIP

Buehler, Charlotte Bertha, Ph.D., Visiting Professor, Clark University, Worcester, Mass.; Lecturer, College of the City of New York, New York, N. Y.

Clark, Frances H., Sc.D., Metallurgist, Western Union Telegraph Company, New York, N. Y.

Claude, Albert, M. D., Associate, Rockefeller Institute for Medical Research, New York, N. Y.

Cox, Edward H., D.Sc., Professor, Chemistry, Swarthmore College, Swarthmore, Pa.

Crane, E. J., D.Sc., Editor *Chemical Abstracts*, Ohio State University, Columbus, Ohio.

Darken, Lawrence Stamper, Ph.D., Physical Chemist, U. S. Steel Corporation, Research Laboratory, Kearny, N. J.

Dingle, John Holmes, Ph.C., Sc.D., M.D., Instructor and Francis Weld Peabody Fellow in Medicine, Instructor in Bacteriology and Immunology, Harvard Medical School; Assistant Physician, Thorndike Memorial Laboratory; Assistant in Medicine, Boston City Hospital, Boston, Mass.

Dorcas, Merrill J., Ph.D., Technical Consultant, Manager Specialties Department, Carbon Sales Division, National Carbon Company, Inc., Cleveland, Ohio.

Harvey, Burwell T., A.M., Professor, Chemistry, Morehouse College, Atlanta, Ga.

Holmes, Ralph J., B.S., Lecturer, Mineralogy, Columbia University, New York, N. Y.

Kertesz, Francois, Sc.D., Ch.E., Research Chemist, E. I. du Pont de Nemours and Co., New York, N. Y.

Kurrelmeyer, Bernhard, Ph.D., Professor, Physics, Brooklyn College, Brooklyn, N. Y.

Lorentz, John J., M.S., Instructor, Biology, St. John's University, Brooklyn, N. Y.

Renn, Louis Hancock, Public Relations Counsellor, New York, N. Y.

Russell, John B., M.S., Assistant Professor, Electrical Engineering, Columbia University, New York, N. Y.

ASSOCIATE MEMBERSHIP

Coraje, Eliseo Jesus, D.Sc., LL.D., Anthropology, Psychology, Retired, San Diego, Calif.

Corwin, Alsoph H., Ph.D., Associate Professor, Chemistry, Johns Hopkins University, Baltimore, Md.

Coryell, Charles D., Ph.D., Assistant Professor, Chemistry, University of California, Los Angeles, Calif.

Hamre, Christopher J., Ph.D., Professor, Zoology; Chairman of Department, University of Hawaii, Honolulu, T. H.

Lowenhaupt, Henry Stewart, B.S., Graduate Student, Yale University, Sterling Chemistry Laboratory, New Haven, Conn.

Newman, LeRoy Lafayette, Jr., M.S., Junior Physicist, Southern Regional Research Laboratory, Schenectady, N. Y.

Smoluchowski, Roman, Ph.D., Research Physicist, General Electric Research Laboratory, Schenectady, N. Y.

Spurlin, H. M., Ph.D., Head, General Research Group, Hercules Experiment Station, Wilmington, Del.

West, Cutler D., Ph.D., Research Chemist, Polaroid Corporation, Cambridge, Mass.